

SEPARATE SEWER SYSTEM
FOR ARLINGTON HEIGHTS ILLINOIS

BY
J. G. CHANDLER
R. S. CLAAR
R. NEUFELD

ARMOUR INSTITUTE OF TECHNOLOGY

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$$\{ \quad \quad \quad \}$$

Figure 1 consists of two scatter plots. The left plot shows a positive correlation between the number of children and the number of mothers, with a regression line indicating a positive slope. The right plot shows a negative correlation between the number of children and the number of mothers, with a regression line indicating a negative slope.

AT 248
Chandler, J. G.
Design of a seperate sewer
system and disposal plant

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A C K N O W L E D G E M E N T.

We hereby take this means of thanking both Mr. W.S.Shields, and Professor A.E.Phillips for such data and valuable information as was needed for the completion of this thesis.

DESIGN OF
A
SEPARATE SEWER SYSTEM
AND
DISPOSAL PLANT
FOR THE
TOWN OF ARLINGTON HEIGHTS,
ILLINOIS.

A THESIS PRESENTED BY

W. J. Chandler

W. J. Chandler

AND
Ralph Neufeld

TO THE
PRESIDENT AND FACULTY
OF

ILLINOIS INSTITUTE OF TECHNOLOGY
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ARMOUR INSTITUTE OF TECHNOLOGY,
FOR THE DEGREE OF
BACHELOR OF SCIENCE IN CIVIL ENGINEERING,
HAVING COMPLETED
THE PRESCRIBED COURSE
IN CIVIL ENGINEERING.

J. C. Monin
Dean of Cult. & Rec.

W. J. Chandler
Prof. Civil Engineering
H. M. Raymond
Dean of Eng. & Arch.

Arlington Heights at the present time has a population of approximately two thousand. Many of the inhabitants are retired farmers and merchants who have built permanent homes in the town. They lately realized the necessity for installing a sewer system and accordingly asked for bids for constructing the same. Mr. W. S. Shields was awarded the contract and drew up plans for a combined sewer system and disposal plant.

Through the kindness of Mr. Shields we were enabled to obtain level notes and other valuable information from which the system appended hereto was calculated.

In order to better understand the existing conditions in Arlington Heights at the present time a trip was made to the town to note the nature of the soil, the best location for the outfall, the location of old sewer lines and any other general information that might be obtained. The natural drain of the land was found to be from the northwest part of the town to the southeast. The creek into which the sewer was to empty was found to contain too small a quantity of water and of too slow a velocity to allow the sewage to be emptied into it direct from the tank, and for this reason further purification was deemed necessary. In order to take care of this it was decided to install filter beds to be operated in conjunction with the septic tank.

With this information on hand an outline of the proposed work was laid out. The procedure decided upon was as follows:-

- A. Preliminary Data-
 - 1. Surveys
 - a. Map of Town.--Layout of Streets, blocks, lots, etc..
 - 2. Rainfall and runoff data.
 - Precipitation and Nature of the soil.



3. Population per lot

B. Design.

1. Profiles of each street and Topographic map.
2. Velocities, and discharge--
Size of sewers
3. Man-holes, flush-tanks, catch-basins, lamp-holes, interceptors, etc..
4. Purification Plant.

C. Contracts, Specifications and Estimate of cost.

1. Engineering and supervision.
2. Construction of sewers.
3. Construction of purification works.

The level notes were obtained from Mr. Shields as stated in the preceeding paragraph, thereby facilitating the work along this line. A map of the town was also obtained from the same source.

The profiles of each street containing sewers were then plotted on profile cloth so as to be durable and suitable for binding. The north and south streets and the east and west streets were plotted on separate sheets in order



to make the checking of street intersections as easy as possible. Enough space was allowed below the profile of each street to show the location of man-holes and catch-basins on a plan view.

The next step was to draw the topographic map of the town. Upon the print showing the subdivision of the town, contours were plotted at two foot intervals. A tracing was made from this drawing in order to determine the layout of the sewer lines.

From this map it was found that the natural slope of the soil was from northwest to the southeast. The sewers were begun at the village limit on Ives and run in a south and easterly direction. The main lines of the sewer were designed to run North on State, South on Vail and Hickory, and East on Miner. By making the system combined in the north part of the town it was found that many of the old sewers could be incorporated into the system. In the Southwest part of town it was also found advisable to utilize a sewer installed at a previous date.

Assuming each lot as 25 feet wide, the population being taken as four persons per lot, gives a population of 32 per hundred feet of sewer when the houses are inhabited on both sides of the street. For 66 foot lots six persons were figured to the lot.

By means of Chezy's formula,
$$V = c\sqrt{RS}$$



Where V = velocity

r = hydraulic radius

S = slope

c = constant determined by Kutter's
Formula

$$C = \frac{41.6 + \frac{.00281}{S} + \frac{1.49}{n}}{1 + \left(41.6 + \frac{.00281}{S}\right) \frac{n}{\sqrt{R}}}$$

(n) being the coefficient of roughness, which
for this case = .013
giving c = 74.55

the flow of an 8" pipe flowing half full at a
grade of 6' in one Thousand was found to be 2.31
feet per second; since

$$d = \frac{D}{2} \quad \text{and} \quad r = 0.25D = 0.166'$$

$$v = 74.55 \sqrt{.166 \times .006} = 2.31 \text{ ft. per sec}$$

which will be used for sanitary sewers of this
diameter and grade.



Storm water calculation.-

By means of the Bürkli-Zeigler formula

$$Q \leftarrow Rc \sqrt[4]{\frac{S}{A}}$$

where $c =$ constant-- 0.2 for unpaved surface.

R : Average rate during heaviest
Fall in cu. ft. per acre.

S = General fall of area per 1000

A = Drainage area in acres.

Q = Cu. ft. per sec. per acre
reaching sewers

the storm water was calculated.

By consulting Folwell's "Sewerage", a table was found which gave the computed values of velocity and discharge for different size sewers on various grades, from which data the design of the sewers was obtained by selecting a sewer of such size and grade as would carry the required sewage and still not have too high or low velocity.

A flush tank was used at the dead end of each sanitary sewer, the details of which are shown in the accompanying drawings. Each tank should discharge 500 to 800 gallons each 24 hours intermittently throughout the system.

Man-holes are placed at each street intersection and at intervals where needed so that the distance between same shall not exceed 350 feet. Lamp-holes will be used wherever it is found necessary.

Interceptors and storm Over-flows were required at the corners of Euclid and Walnut, and Hawthorne and Haddow. Details shown in drawings attached.

A junction and storm overflow was also required to connect the old sewer with the new system on State Road near Chicago; the drawings of which are also hereto attached.

The septic tank and filter beds were considered under their specifications and drawings.

Catch basin will be placed according to the drawings shown on the profile sheets, and the details shall be the same as shown in the drawings of same herein.



*
*
* SPECIFICATIONS *
* AND *
* FORMS *
*
*
*

N O T I C E T O C O N T R A C T O R S .

Sealed proposals will be received at the
office of the Sewer Commission _____
in the Town of A _____
until _____ o'clock _____ on the _____
day of _____ 19 _____, for constructing
sewers in _____

Forms of proposals, copies of the specifications and instructions to contractors may be obtained of the Engineer; and the plans and profiles may be seen at his office.

Each bid must be accompanied by a deposit of \$ _____ as a guarantee of the good faith of the bidder.

The Sewer Commission reserve the right to reject any or all bids.

ADDRESS,

ENGINEER.

T O C O N T R A C T O R S .

1. All bids must be made upon the printed forms, to be obtained at the office of the Engineer, and enclosed in a sealed envelope, directed to the Engineer of Sewers, and endorsed upon the outside of the envelope, PROPOSAL FOR CONSTRUCTING SEWERS IN THE TOWN OF
_____.

2. Each bid must be accompanied by a deposit of _____ Dollars, to be left in the hands of the Town Clerk, subject to the conditions specified in the proposal hereto annexed, as a guarantee of the good faith of the bidder.

3. Bids shall state the price per lineal foot of pipes of each size laid as herein specified, and for the various depths of trench named, also for all other items enumerated in the schedule opposite, which price shall be in full for all labor and materials required for the complete execution of the work.

4. All prices must be written in words, and also stated in figures.

5. The place of residence of each bidder must be given after his signature, which must be written in full. When firms bid, the individual names of the members shall be signed in full, and the firm name added.

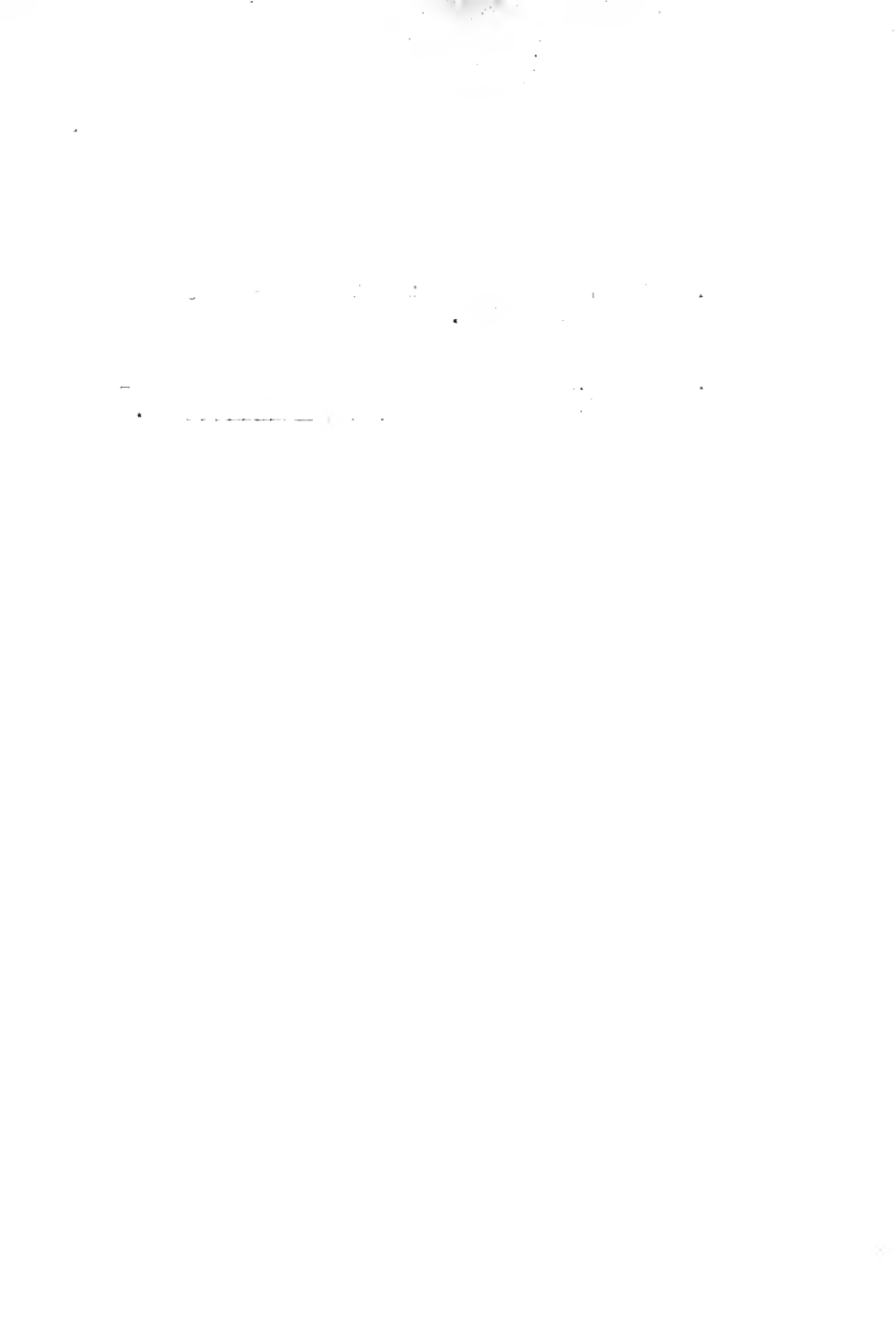
6. The name of the contractor must be filled in the blanks left for that purpose.

7. The Town of _____ reserves the right to reject any or all bids. ---



8. Bidders are requested to be present at the opening of the bids.

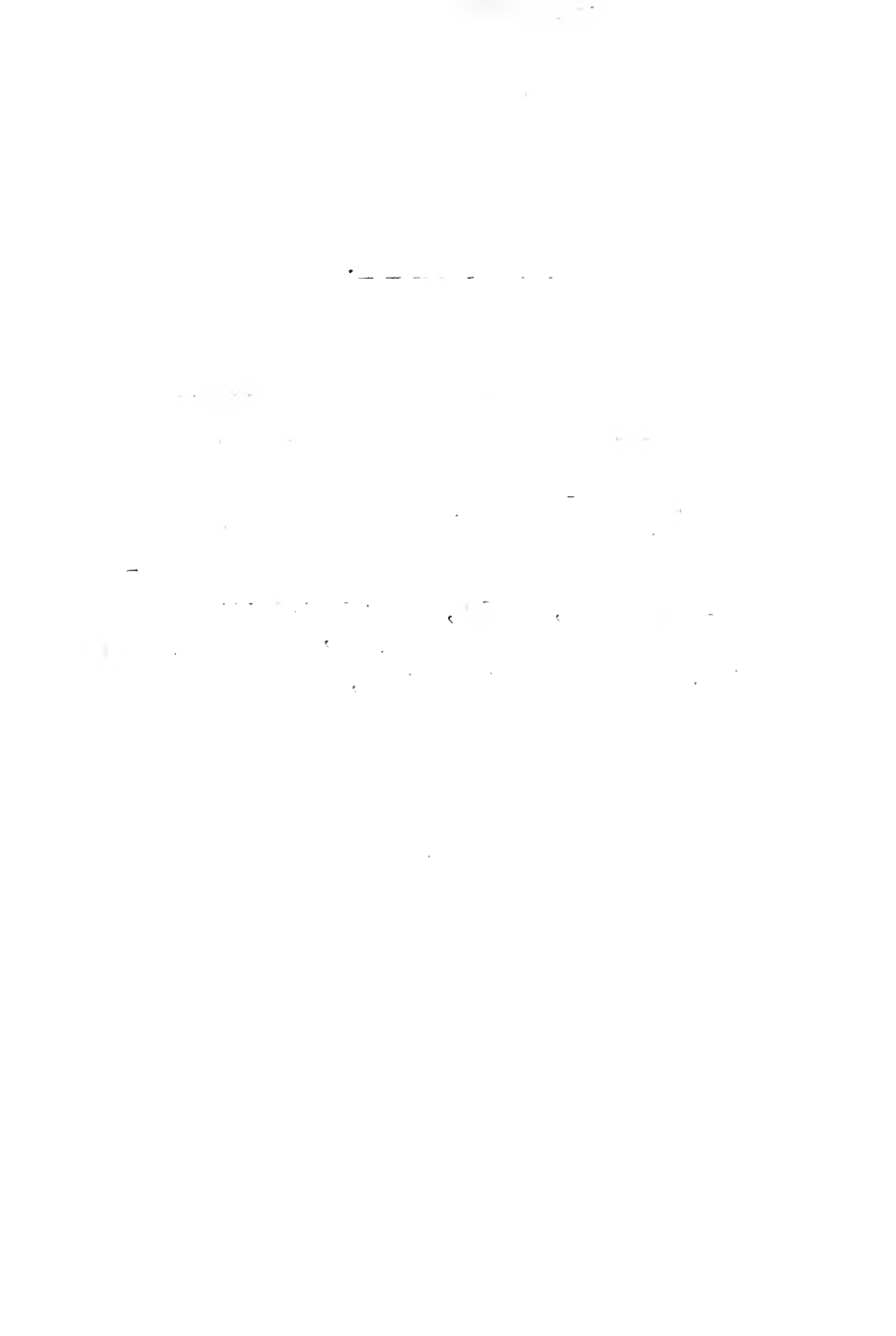
9. The bond required of the successful bidder shall be in the sum of \$_____.



P R O P O S A L.

TO THE SEWER COMMISSION OF THE TOWN OF _____

GENTLEMEN:- The undersigned hereby propose to furnish all of the materials and do all of the work required to complete such amount of the above mentioned work as shall be awarded to the undersigned by the Town of _____ in a first class, manner, and in accordance with the specifications hereto annexed, and the plans and drawings of the same on file in your Engineer's office, at the following prices, viz:



A R T I C L E S O F A G R E E M E N T .

BETWEEN ~~THE~~ TOWN OF _____
PARTY OF THE FIRST PART, AND _____
CONTRACTOR, PARTY OF THE SECOND PART, FOR BUILDING
_____ SEWERS IN _____

This Agreement, made and entered into this
_____ day of _____ in the
year one thousand _____ hundred _____,
by and between the Town of _____,
_____ party of the first part, and _____ -
_____ Contractor, party of the second part.

WITNESSETH, Whereas, The Town of _____
_____, in the State of _____,
_____, by virtue
of the authority vested in the Sewer Commission by
Legislature of the State of _____
and by the Charter and Ordinances of the Town,
agree to let unto the said _____
Contractor, the work of constructing certain _____
_____ Sewers, as per plans and pro-
files of the work on file in the office of the
Engineer of Sewers.

NOW, THEREFORE, in consideration of the pay-
ment and covenants hereinafter mentioned to be made
and performed by said party of the first part, the
said _____ hereby covenants
and agrees to do the work above mentioned in a sub-
stantial and workmanlike manner, in conformity with



the plans, profiles and specifications of such work on file in the office of the Engineer, in strict obedience to the directions which may from time to time be given by the said Engineer or his duly authorized assistants, and in accordance with the following specifications.

S P E C I F I C A T I O N S F O R S E W E R S .

EARTHENWARE PIPE SEWERS.

1. The sewers shall be constructed of first quality vitrified, salt-glazed sewer pipe, sound and well burned throughout their thickness, impervious to moisture, of smooth and well glazed exterior and interior surfaces, free from cracks, flaws, blisters, fire-checks, and all other imperfections, circular in the bore, of true form in their lengths, whether straight or curved, internally of the exact specified diameter, and of uniform standard thickness.

2. All pipe shall be socket pipe, with true and circular sockets concentric with the bore of the pipe, and shall be furnished in pieces two feet long. For all junction pieces, a well fitted vitrified stopper shall be furnished, without charge.

3. A "Y" branch connection of inches in diameter shall be provided every twenty-five feet on each side, when ordered by the Engineer.



IRON PIPE.

4. Iron pipe shall be used where the sewer runs under or through waterways, either natural or artificial, or under railroad, or wherever it is deemed necessary by the Engineer. The joints shall be of lead properly caulked. The lengths of pipe, their diameter and thickness to be as directed by the Engineer. The weight of each pipe shall be plainly marked on it before leaving the factory.

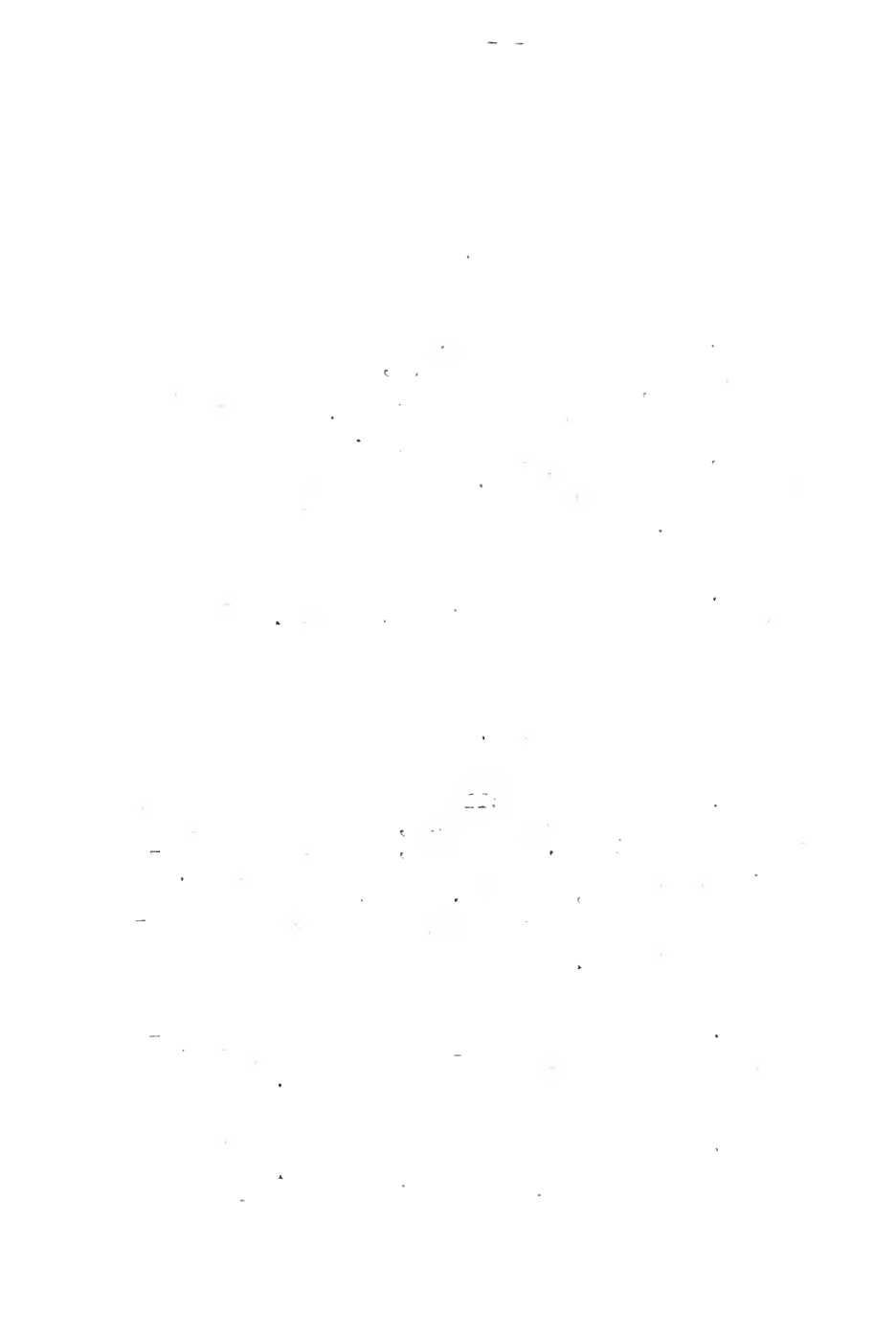
5. The iron pipe shall be paid for by the ton, laid in place with joints complete.

LOCATION.

6. The sewers shall be located on the lines shown on the plans of the work, and will be staked out by the Engineer. This line, whenever practicable, will be on the center line of the street. The Commissioners, however, reserve the right to move the line of sewers to the right or left whenever obstructions are met which render a change of line desirable.

7. The contractor will be required to preserve all stakes and bench-marks until permission is given by the Engineer to remove them.

8. The line for trenches will be indicated by stakes set at one side of the trench. A width of at least two feet, on the side of the trench



where the stakes are, shall, as the work progresses be kept free from obstructions.

EXCAVATION.

9. All excavations shall be by open cut from the surface. No tunneling will be allowed, except written permission be previously obtained from the Engineer.

10. The contractor will be required to keep the sides of the excavation vertical, by bracing or otherwise; but no allowance will be made therefor unless the same is left in the trench by written order of the Engineer.

11. The excavation, at the bottom, is to be made and shaped as nearly as possible to fit the lower half of the pipe to be laid, with holes cut at the joints for the sockets to rest in, so that the pipe shall have uniform bearing on the ground from end to end.

12. At the height of half the diameter of the pipe from the bottom, that is, at the height of the greatest horizontal diameter of the pipe, all trenches are to be eighteen inches wider than the greatest diameter of the pipe to be laid therein.

13. The trench shall be dug to within six inches of grade by measurement from the witness stakes on the surface. The last six inches shall be taken out after the grade pegs have been set in the bottom of the trench by the contractor under the direction of the Engineer.



14. The excavations for all man-holes, flush tanks, and other accessories shall be sufficient to leave at least one foot in the clear between their outer surface and the embankment or timber which may be used to protect it.

15. The approximate depth of the cutting will be given by the Engineer before the excavation is begun. Grade and line will be given by the Engineer every twenty-five feet at the bottom of the trench, on stakes to be furnished and set by the contractor; or on overhead pieces, from which the position of the invert may be determined by a line parallel therewith.

16. In no case, without previous written permission from the Engineer, shall more than 500 feet of trench be opened in advance of the completed sewer and on the completion of each 500 feet of sewer, the street surface must be restored in good condition and all surplus material and rubbish from that section be immediately removed.

17. The material excavated shall be laid compactly on the sides of the trench and kept trimmed up so as to be of as little inconvenience as possible to the traveling public and adjoining tenants.

18. The contractor shall not obstruct the gutter of any street, but shall use all proper measures to provide for the free passage of surface water along the gutters.

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19. The contractor shall provide for all water courses and drains interrupted during the progress of the work, and replace them in as good condition as he found them. The use of any portion of the sewers shall not be constructed as an acceptance of them by the Commissioners.

20. No additional compensation shall be allowed for excavating man-holes, or flush tanks over the price per lineal foot for trench.

21. The contractor shall keep the trenches free from water during the progress of the work, as no pipe of masonry shall be laid in the water.

PROTECTION OF PROPERTY.

22. The contractor shall, at his own expense, shore up, protect, and make good, as may be necessary, all buildings, walls, fences or other property injured, or liable to be injured during the progress of the work; and the contractor will be held responsible for all damage which may happen to the neighboring property from neglect of this precaution, or from any other cause connected with the prosecution of the work.

PROTECTION OF WATER AND GAS PIPES, ETC.

23. The contractor shall do whatever may be necessary to keep in position and to protect from

injury all water and gas pipes, lamp posts, service pipes, and all other fixtures which may be met with in carrying on the work.

24. In case of any of the said gas or water pipes or other fixtures be damaged, they may be repaired by the parties having control of the same, and the expense of such repairs shall be deducted from the amounts which may become due the contractor.

PROTECTION AGAINST ACCIDENTS.

25. The contractor shall erect suitable barriers around all excavations, to prevent accidents to passengers on the streets, and shall place and maintain during the night sufficient red lights on or near the work.

26. The contractor shall have charge of, and be responsible for, the entire line of sewers for whose construction he has contracted, until their completion and acceptance. He shall also be liable for any defects which may appear in his work before the final payments specified herein.

BACK-FILLING.

27. The earth filled around and on top of the sewers shall be free from stones, and tamped with the utmost care, so as to obtain the greatest compactness and solidity possible. In filling, the earth shall be kept at the same height on both sides of the sewer when required by the Engineer. The earth shall be rammed in layers of not more than one foot thick up to the surface of the street, and in no case shall the number of men filling be more than twice the number of men ramming. In lieu of ramming, the earth may be thoroughly puddled.

28. The contractor is required not to sell, remove or permit to be removed from the line of the work, before the trench shall have been refilled, any sand, gravel, or earth excavated therefrom which may be suitable and required for refilling.

29. The trench must in all cases be filled to the proper grade with suitable material. Should there be a deficiency of proper material for refilling the trench the contractor will be required to furnish the same at his own cost.

REPAVING AND RESTORING STREETS.

30. When the pavement has been removed, it must be **replaced** by the contractor and left in as good condition as it was before being removed.

31. As the trenches are filled in and the work completed, the contractor shall remove all

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surplus material, without additional compensation, to localities not interfering with the regulations of the Town, and shall leave all roads and places free, clean, and in good order.

32. All work of restoring the surface of the streets shall be done to the satisfaction of the superintendent of streets.

33. If at any time during a period of one year from the date of the final completion and acceptance of the sewer, the roadway on the line of the sewer shall require regrading, repaving or regravelling, by reason of the settlement of the trenches, the Commissioners shall notify the party of the second part to make the repairs so required; and if the party of the second part shall neglect for a period of ten days to make such repairs to the satisfaction of the Commissioners, then the Commissioners shall have the right to cause the repairs to be made, and pay the expense thereof out of the sum retained for that purpose.

EMBANKMENT.

34. Where embankment is necessary to support the foundation of the sewer, or to cover or protect it in any way, it shall be made of the width and slopes as shown on the plan. The surface of the ground receiving the embankment shall be carefully cleared of all muck or unsuitable material, of whatever nature.



35. The embankment shall then be formed of good loam or gravel, free from all stones over four inches in diameter, and of those below that size in a proportion not exceeding one part of stone to three parts of earth in any place.

36. If built to support the foundation of the sewer, the material is to be deposited in layers of not more than six inches in thickness, each layer to be separately compacted by heavy iron rollers, or, where these cannot be used, by heavy paver's rammers. No breaks, steps or irregularities in the distribution of material or formation of the layers will be allowed, and the whole embankment is to be carried up evenly so as to make a compact and solid foundation.

PIPES----HOW LAID.

37. All pipes over eight inches in diameter shall be laid with a straight edge. One end of the straight edge shall be placed on the nearest grade peg and the other on the flow line of the pipe already laid, and the pipe shall be so adjusted as to be in contact with the straight edge throughout its length.

38. All pipes eight inches and less in diameter, except house branches, shall be laid in the following manner:- A mason's line shall be tightly stretched parallel to the grade and slightly above the sockets of the pipes. This line shall be supported over the centre at distances not greater than twenty-five feet



apart. The exact grade for each pipe shall be obtained by measuring down from this line to the invert of the sewer.

39. Especial care must be taken to lay the pipe to the exact grade and line.

40. All pipes, previous to being lowered into the trench, shall be fitted together and matched, so that when joined in the trench they may form a true and smooth line of pipes. No pipes shall be trimmed in any case. Pipes which do not fit truly shall be rejected.

JOINTS.

41. A gasket of oakum or other material approved by the Engineer shall be pressed into the joint around the entire circumference of the pipe to prevent the entrance of cement to the inside of the pipe. No joint shall be cemented until the gasket of the next joint in advance has been completed.

42. The cement shall be pressed into the space between the socket and spigot so as to entirely fill the space, and the bevel joint at the end of the socket shall be smoothly and evenly made. Special care must be taken to make perfect joints at the bottom of the pipe.

43. The excavation made for the socket of the pipe



shall be filled with sand to support the cement firmly in position. When the joint is completed great care must be taken not to disturb the pipes.

CEMENT.

44. The cement for filling the joints shall be pure fresh ground cement, of best quality, with only enough water added to give it the proper consistency, and shall be mixed only as needed for use.

BRANCHES, "T'S", ETC..

45. The "Y" branches, "T's", lamp-holes, hand-holes, and man-holes shall be placed at points indicated by the Engineer. They shall not be covered until he has noted and recorded their exact position. The "Y" branches shall be elevated to correspond to the lateral sewers and house drains entering them. They shall be closed with earthenware caps, and the space above the cap shall be filled with sand, covered with a thin coating of cement.



SPECIAL PIECES.

46. Special pieces, such as "Y" branches, curves, "T's", etc., shall be made according to drawings furnished by the Engineer.

SEWER TO BE KEPT CLEAN AND FREE FROM WATER.

47. All the pipes must be kept thoroughly clean, and no water will be allowed to flow through them, during the construction of the sewers.

48. When the trench is left for the night, or the pipe-laying is stopped by rain storms or any other cause, the ends of the pipes must be closed water-tight with bricks and cement.

49. When running quicksand or other treacherous ground is encountered, the work shall be carried on day and night, should the Engineer so require.

ARTIFICIAL FOUNDATION.

50. Whenever ordered by the Engineer, in writing, the contractor shall excavate to such

depth below grade as the Engineer may direct, and the excavation shall be brought to grade with such material as shall be ordered by the Engineer, the extra work to be paid for upon the estimate of the Engineer.

51. If the contractor excavates below grade without orders, he will be required, at his own expense, to fill the excess of excavation with such material as the Engineer may direct.

52. Concrete foundations shall be placed under the flush-tanks and man-holes.

ROCK CUT.

53. When blasting is resorted to for making the excavations, the trench shall be covered carefully on the top and sides with heavy timbers and plank, to prevent fragments of rock from being thrown out.

In rock cut, the rock shall be taken out of the trench to a depth of four inches below the bell of the pipe when laid. The refilling from the bottom of the trench to go one foot above the bell of pipe shall be of earth, free from stones, or such material as shall be approved by the Engineer.

54. All damages or injury to persons or property resulting from blasting operations, or from neglect in properly guarding the trenches, must be paid by the contractor; and no compensation to said contractor for losses thus incurred will be allowed.

LAMP-HOLES.

55. Lamp-holes shall be constructed by placing an eight-inch "T" branch vertically in the sewer, and bringing it up to within one foot of the street surface by adding pipes of the same diameter. The top of the lamp-hole shall be protected by cover, as shown in the detail drawing.

MAN-HOLES.

56. The man-holes shall be constructed of hard brick, laid in cement mortar, and plastered outside with cement mortar and washed inside with pure cement. The thickness of the wall shall be eight inches. The bottom shall be formed of concrete, and the top of the concrete shall be on a level with the bottom of the sewer pipe, and the top of the cover on a level with the street surface. Particular care must be taken in forming the bottom of the man-holes to make the curves of tributary sewers as easy as possible. The top shall be covered with a perforated cast iron cover, as in detail drawings.



FLUSH TANKS.

57. Flush tanks shall be constructed of hard-burned bricks, carefully laid in cement mortar, so as to be water tight. They shall be plastered outside and inside with cement mortar. (For form, size and details see drawing.)

58. The emptying device for the flush tanks shall be selected and purchased by the COMMISSIONERS and shall be properly set by the contractor.

59. The water supply pipe, within the flush tank, and extending through the wall and one foot outside of the wall, together with a suitable brass stopcock for regulating the water supply, shall be furnished by the contractor.

BRICK MASONRY.

60. None but the best quality of whole, sound, well shaped brick, burned hard entirely through, shall be used. They are to be culled when delivered upon the ground, and all bats and imperfect bricks are to be immediately removed from the work.

All bricks are to be thoroughly wet immediately before laying. Every brick is required to be laid in a full and close joint of cement mortar, on its beds, ends, and sides, at one operation. In no case is mortar to be slushed in afterwards.

CEMENT MORTAR.

61. All cement mortar for man-holes and concrete, shall be made of best quality of fresh ground cement and clean sharp sand, in the proportion of one measure of cement to two of sand. The sand and cement shall be thoroughly mixed dry, and such quantity of water added as to form a paste of the proper consistency. All mortar shall be fresh for the work in hand. No mortar that has begun to set shall be used. Every facility for inspecting and testing the cement shall be furnished by the contractor.

CONCRETE.

62. The concrete used on the work shall be made of three parts of cement mortar(made as described) and two parts of clean gravel, or broken stone. It shall be quickly and thoroughly mixed, and immediately deposited in place.

MATERIALS.

63. All materials shall be furnished by the contractor, and shall be subject to inspection and acceptance by the Engineer.

LENGTH OF SEWER...

64. The length of the sewer will be measured on the center line of the completed sewer.



INTERPRETATION OF TERMS.

65. Wherever the word "Commissioners" is used in these specifications, it shall be held to mean the Board of Sewer Commissioners of the Town of

Wherever the word "Engineer" is used, it shall be held to mean the Engineer in charge of the sewers, or his authorized assistant.

Wherever the word "Contractor" is used, it shall be held to mean either any contractor or firm of contractors, or any member of a firm, contracting for work herein specified.

GENERAL STIPULATIONS.

66. The contractor shall start the work at such points on the line of the sewer as the Engineer may from time to time direct, and shall progress from the outlet, or towards the outlet, at the option of the Engineer.

67. No pipes or masonry shall be laid in freezing weather.

68. None of the work shall be sub-let without the permission of the Commissioners.

69. The contractor shall also do such extra work in connection with his contract as the Engineer may in writing specially direct, and in a first-class manner, but no claim for extra work



shall be allowed unless the same was done in pursuance of a written order, as aforesaid, to do the work as such and the claim presented at the first estimate after the work was done. Extra work shall be paid for on a basis of 15 per cent in advance of the actual cost of labor and material as determined by the Engineer.

70. Although the Engineer may assent to special means for prosecuting work in difficult cases, this will not relieve the contractor of the responsibility as to the result.

71. The contractor upon being directed by the Engineer, shall remove, or rebuild, or make good, at his own cost, any work which the latter shall decide to be deficiently executed.

72. No work shall be covered until it has been examined by the Engineer or inspector.

73. The contractor will be required to observe all Town Ordinances in relation to obstructing streets, keeping open passageways and protecting the same where exposed, and generally, to obey all Ordinances, Rules and Regulations controlling or limiting those engaged on the work.

74. At the suspension of any work the trenches shall be filled and the street left clean and free for travel.

75. The contractor shall give notice in writing, at least twenty-four hours before breaking ground, to all persons (Superintendents, Inspectors, or otherwise) in charge of property,

streets, gas pipes, water pipes, railroads or otherwise, that may be effected by his operations. And it is further agreed that the said part__ of the second part shall not cause any hindrance to or interference with any such company or companies in protecting their said work; but that the said part__ of the second part will suffer the said company or companies to take all such measures as they may deem necessary for the purpose aforesaid.

76. The Commissioners shall have a right to make alterations in the line, grade, plan, form or quantity of the work herein contemplated, either before or after the commencement of the work. If such alterations diminish the quantity of work to be done they shall not constitute a claim for damages, or for anticipated profits on the work dispensed with; if they increase the amount of work, such increase shall be paid for according to the quantity actually done, and the price or prices stipulated for such work in this contract.

77. If any person employed by the contractor on the work shall appear to the Engineer to be incompetent or disorderly, he shall, on the requisition of the Engineer, be immediately discharged, and such person shall not be again employed upon the work without the permission of the Engineer.

78. The work embraced in this contract shall be begun within _____ days after the award of this contract, and carried on regularly and uninterruptedly thereafter, with such a force as to secure its full completion by _____; but should the work be delayed or interrupted by the Town, after the service of such notice, the contractor shall be



entitled to an extension of time equal to the time of such interruption or delay, which shall be determined by the Engineer; the time of beginning, rate of progress, and time of completion being essential conditions of this contract; and if the contractor shall fail to complete the work by the time above specified, the sum of \$_____ per day, for each and every day thereafter, until such completion, shall be deducted from the moneys payable under this contract. This sum shall be in addition to any penalties otherwise specified.

79. No charge shall be made by the contractor for hinderances or delay from any cause during the progress of any portion of the work embraced in this contract.

80. No variance from the regular prices named in the proposal will be made or allowed, whether the material through which the trenches are excavated is hard or soft, or whether it is composed of rock, boulders, walls or common earth. The Board of Town Commissioners will not consider themselves bound to notify or inform contractors where material that is hard or expensive to excavate occurs, or will be liable to be encountered. Furthermore no compensation for trenching done in excess of the orders of the Engineer will be allowed.

81. A watchman shall be employed on the work at night whenever in the opinion of the Engineer it shall be necessary.

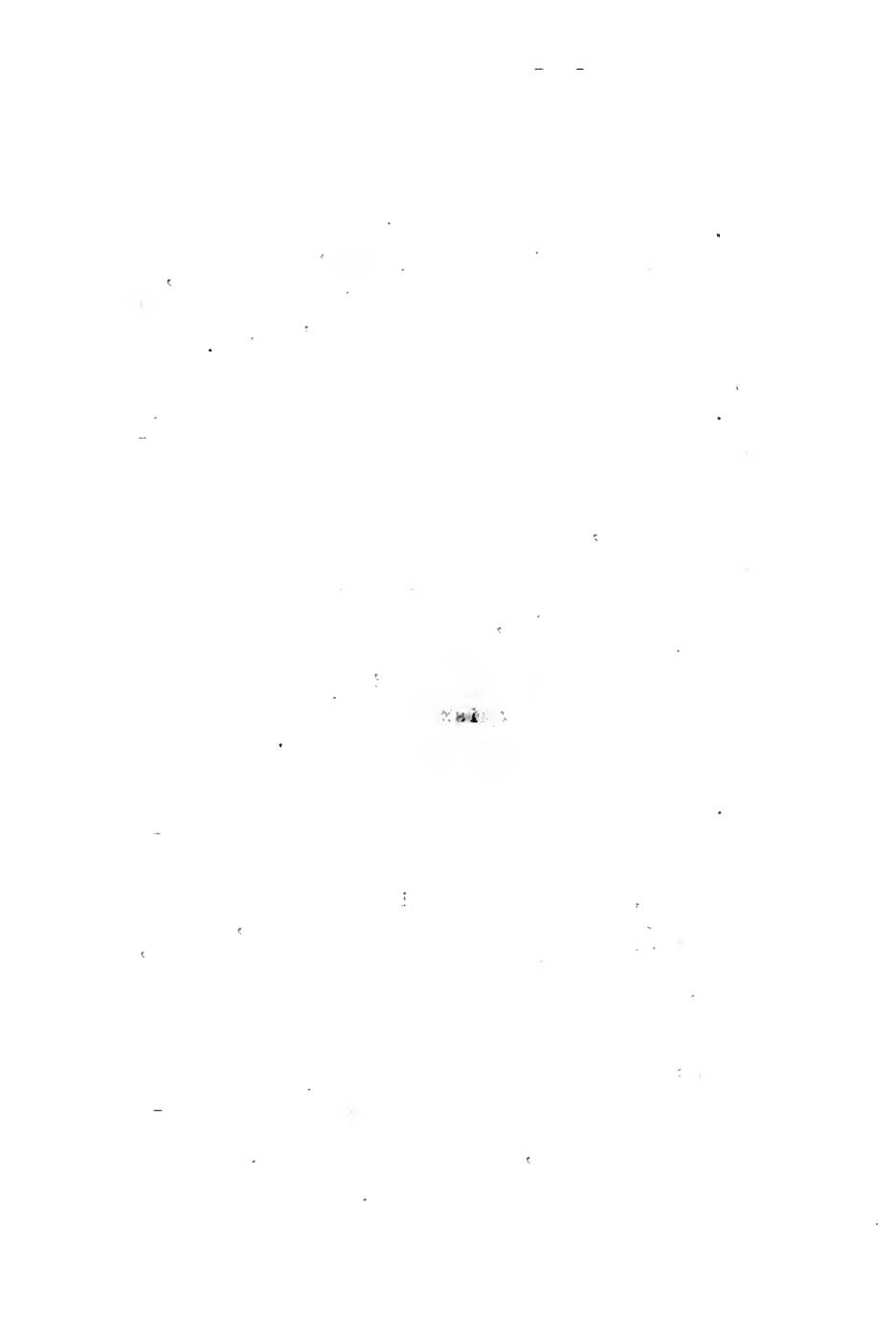
82. House branches shall be laid to a point just within the curb lines where the Engineer shall direct.



83. Should any dispute arise between the Engineer and contractor as to the true meaning of the drawings or specifications in any point, or as to the manner of the execution of the work, or the quantity of the work executed, the decision of the former shall be final and conclusive.

84. And the said _____, contractor, hereby expressly binds himself to indemnify and save harmless the Town of _____ from all suits or actions of every name and description brought against the said Town, for, or on account of any injuries or damages received or sustained by any party or parties by or from the said _____ or his servants or agents, in the construction of said work, or by or in consequence of any negligence in guarding the same, or any improper materials used in its construction, or by or on account of any act or omissions of the said _____, or his agents.

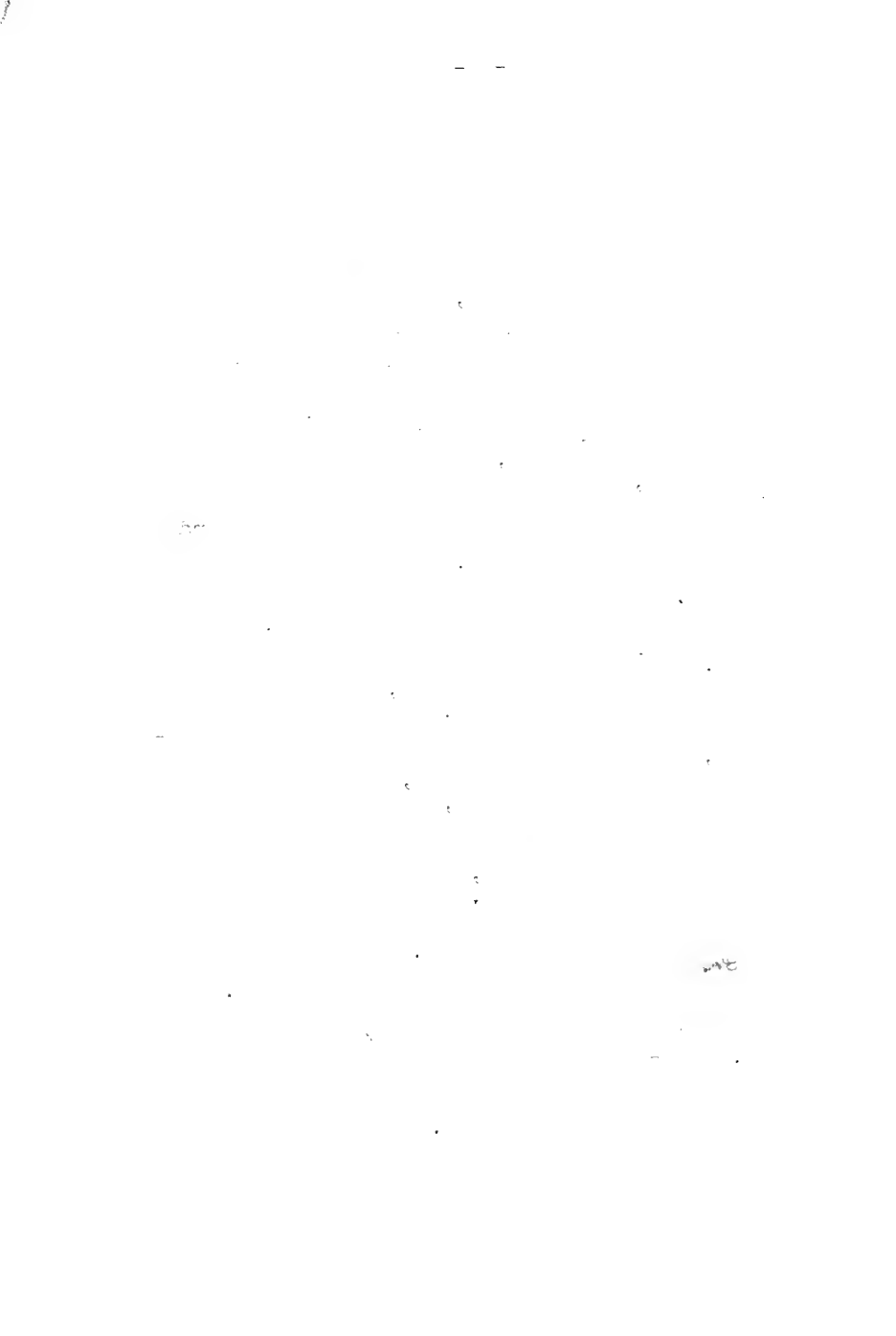
85. Said part__ of the second part further agrees that in case of failure to furnish materials or execute the work in accordance with the plans and specifications to the satisfaction of the Engineer, or to proceed with the same as rapidly as the said Engineer shall direct, that it shall be lawful for the said Sewer Commission, after three days written notice of their intention so to do, by serving the notice on the party of the second part either personally or by leaving a copy at _____ usual place of business or residence (and if said party of the second part consist of more than one person, then by such service upon either of them), and at the expiration of an additional ten days thereafter to cancel said contract, and relet the same, or proceed to complete the work by the purchase of material and the hiring of labor; and if the sum



so paid for the completion of the said contract shall exceed the sum due the party of the second part under this contract, then the said party of the second part and sureties shall become liable to the party of the first part for any sum by which the expense of so doing the work shall exceed the sum due under this contract as liquidated damages, and not by way of penalty, and the said contract shall thereupon become void, as to the party of the second part, except as to any right of action which may have accrued to the party of the first part against the party of the second part and sureties for not properly proceeding with and completing the work.

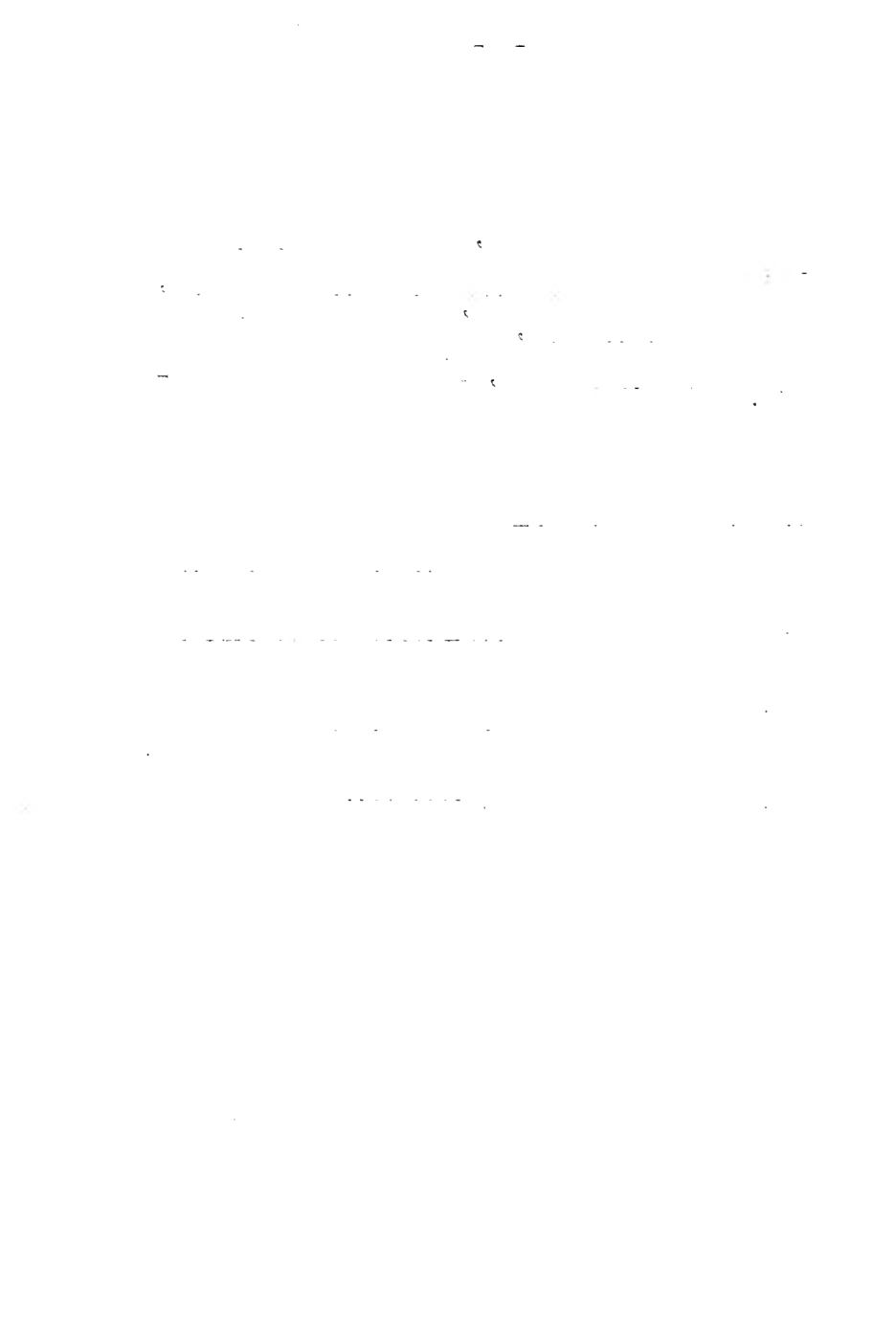
86. In consideration of the completion by said party of the second part, of all the work embraced in this contract, in conformity with the specifications and stipulations herein contained, and in strict accordance with the instructions of the Engineer, the Town of _____, party of the first part, hereby agrees to pay to the party of the second part, the prices named in the "PROPOSAL" which is hereto annexed, and which is hereby made a part of this contract.

87. Payments for the work shall be made monthly upon the estimate of the Engineer. TEN per cent of the amounts due will be retained as a guarantee against poor workmanship and materials. One-half of this reserve will be paid as soon as the work is completed and accepted and the balance at the expiration of one year after the acceptance of the work.



IN WITNESS WHEREOF, the Town of _____
_____ has caused its name to be
affixed by _____,
thereunto duly authorized, and the said _____,
_____, party of the second part
h _____ hand, the day and year afore-
said.

ATTEST:



B O N D .

KNOW ALL MEN BY THESE PRESENTS, That we _____

_____ are held and firmly bound unto the Town of _____
_____ in the sum of _____
_____ Dollars, lawful money of the
United States of America, to be paid to the said
Town of _____, or to its
certain attorneys or assigns, to which payment,
well and truly to be made, we bind ourselves,
our heirs, executors, and administrators, and
each and every of them, firmly by these presents.

Signed and sealed with our seals, and dated
at _____, this _____
_____ day of _____ 1 _____.

THE CONDITION OF THIS OBLIGATION IS SUCH,
That Whereas, the said
.....ha...
entered into a contract with the Town of
.....
bearing date the day of
.....1, which said contract is here-
unto attached.

NOW, THEREFORE, If the said
.....shall well and truly keep and per-
form all the terms and conditions of said contract,
on part to be kept and performed, and
shall indemnify and save harmless the said Town of
.....as therein
stipulated, then this obligation shall be of no
effect, but otherwise it shall remain in full force
and virtue.

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SPECIFICATIONS FOR SEPTIC TANK.
AND FILTRATION PLANT.

CEMENT.

1. The cement shall be first class Portland cement of reputable brand, which shall conform in all respects to the cement specifications herewith annexed. The cement shall be stored in a building which will protect it from the weather. The floor upon which the cement is placed shall be at least six inches above the ground. It shall be stored so as to permit of easy access for inspection and identification of each shipment. A sufficient quantity shall be kept on hand at all times so that the Engineer may have opportunity and time to make tests sufficient to determine its quality. At least twelve days shall be allowed for inspection and necessary tests.

FINE AGGREGATES.

2. The fine aggregate shall consist of sand, crushed stone or gravel screenings passing when dry a screen having $\frac{1}{2}$ inch diameter holes, or a screen having four meshes to the linear inch. It shall be clean, coarse, and free from vegetable loam and other deleterious matter. A gradation of the size of grain is preferred. Mortars composed of one part Portland cement and three parts fine aggregate by weight when made into briquettes shall show a tensile strength of at least seventy per cent of strength of 1:3 mortar of the same consistency, made with the same cement and standard Ottawa sand. To avoid the removal of any wating on the grains which may effect the strength, bank sand shall not be dried before being made into



mortar, but shall contain natural moisture. The percentage of moisture may be determined upon a separate sample for correcting weight. From 10 to 40 per cent more water may be required in mixing bank or artificial sand and for standard Ottawa sand and to produce the same consistency.

COARSE AGGREGATES.

3. The coarse aggregate shall consist of inert material such as crushed stone, or gravel, which is retained on a screen having $\frac{1}{4}$ inch diameter holes. The particles shall be clean, hard, durable, and free from all deleterious material. Aggregates containing soft, flat, or elongated particles, should be excluded from reinforced concrete. A gradation of the sizes of the particles is advantageous. The maximum size of the coarse aggregate shall be such that it will pass a 1 inch ring.

GRAVEL.

4. The gravel shall be composed of clean pebbles, free from sticks and other foreign material, and containing no clay or other material adhering to the pebbles in such quantity that it cannot be likely brushed off with the hand or removed by dipping in water. It shall be screened to remove the sand, which shall afterward be remixed with it in the required proportions.

BROKEN STONE.

5. The broken or crushed stone shall consist



of pieces of hard and durable rock, such as trap, limestone, granite, or conglomerate. The dust shall be removed by a sand screen, to be afterwards, if desired, mixed with and used as a part of the sand, except that if the product of the crushed stone is delivered to the mixer so regularly that the amount of dust, as determined by frequently screening samples, is uniform, the screening may be omitted and the average percentage of dust allowed for in measuring the sand.

WATER.

6. The water shall be free from oil, acid, strong alkalies or vegetable matter.

REINFORCING STEEL.

7. Steel for reinforcement shall be medium steel and have an "ultimate tensile strength of 60000 to 70000 pounds per square inch, an elastic limit of no less than 35000 pounds per square inch, and a minimum elongation of 22% in 8 inches."

PROPORTION.

8. The proportions shall be 1:2:4; that is, one barrel (4 bags) packed Portland cement to 2 barrels (7.6 cubic ft.) loose to 4 barrels (15.2 cu. ft.) loose gravel or broken stone.



HAND MIXING.

9. If the concrete is mixed by hand, the cement and aggregate shall be mixed and the water added on a tight platform large enough to provide space for the partially simultaneous mixing of two batches of not more than one cubic yard each. The sand and cement shall be spread in their layers and mixed dry until of uniform color. This mixture may be spread upon the layer of stone or the stone shoveled upon it before adding the water, or it may be made into a mortar before spreading it with the stone. In the former method the materials shall be turned at least three times, in addition to the mixing of the sand and cement already mentioned, and in addition to the shoveling from the platform to place or into the vehicle for transportation. In the later method, that is, if the sand and cement are first made into mortar, the mass of mortar and stone shall be turned at least twice. Whatever method is employed, the number of turnings shall be sufficient to produce a resulting loose concrete of uniform color and appearance, with the cement uniformly distributed through the mass, the stones thoroughly incorporated into the mortar and the consistency uniform throughout, thus producing a concrete uniform in color, and homogeneous.

MACHINE MIXING.

10. If the concrete is mixed in a machine mixer, a machine shall be selected into which the materials, including the water, can be precisely and regularly proportioned, and which will produce a concrete of uniform consistency and color with the stones and water thoroughly mixed and incorporated with the mortar.



CONSISTENCY.

11. The mixture shall be wet or mushy, so soft that it will flow when agitated, but not so wet as to produce a separation of the materials in transferring to the work.

PLACING CONCRETE.

12. Concrete shall be conveyed to place in such a manner that there shall be no distinct separation of the different ingredients, or in cases where such separation inadvertently occurs, the concrete shall be remixed before placing. It shall be placed in the work immediately after mixing and deposited and removed or agitated by suitable tools in such a manner as to produce thoroughly compact concrete of maximum density. No concrete shall be placed until the reinforcing has been placed and firmly secured by wiring or other method to prevent displacement. Concrete shall be frequently wet for several days to prevent too rapid drying out. Concrete shall not be placed in water, unless unavoidable. Where concrete must be placed under water, unusual care must be taken to prevent the cement from being floated away. This usually can be accomplished in still water by placing the concrete through a large pipe or tube, or by means of a bottom dump concrete bucket.

Before placing fresh concrete, all shavings and debris of every nature must be removed and the old concrete surface thoroughly cleaned from all dirt and scum and laitance and drenched with water. Noticeable voids or stone pockets discovered when the forms are removed, shall be filled immediately with mortar mixed in the same proportion as the mortar in the concrete. The lines and grades of the completed concrete shall accurately conform to the place annexed to and forming a part of the specifications.

PLACING REINFORCEMENT.

13. The reinforcement shall accurately conform in the finished structure to the plans annexed to and forming a part of these specifications. All reinforcement shall be free from rust, scale, or coating of any character, which would tend to reduce or destroy the bond. Before placing concrete the reinforcement must be placed in the position required in the finished structure and each piece or member so firmly fixed as to positively prevent any subsequent displacement.

FREEZING WEATHER.

14. The concrete shall not be mixed or deposited at a freezing temperature, unless special precautions are taken to avoid the use of materials containing frost and to provide means for preventing the concrete from freezing after being placed in position and until it has thoroughly hardened.

FORMS.

15. The lumber for the forms and the design of the forms shall be adapted to the structure and to the kind of surface required on the concrete. For exposed faces the surface next to the concrete shall be dressed. Forms shall be substantially built and secured to prevent movement or deflection during concreting, and tight to prevent leakage of mortar. Before the removal of forms, the concrete shall be carefully

inspected and its strength ascertained. Much care shall be given to this portion of the work, which is fraught with danger under incompetent direction. Forms shall be thoroughly cleaned before being used again.

ORDINARY SURFACES.

16. (a) Surfaces shall have no special treatment further than care in placing the concrete to avoid noticeable voids or stone pockets. Forms shall be wet (except in freezing weather) before placing the concrete against them.

EXPOSED FACES

16. (b) Faces exposed to view shall be made smooth by thrusting a spade or chisel through the concrete close to the form to force back the layer stones and prevent stone pockets. The forms shall be thoroughly wet or greased with crude oil before placing the concrete against them.

CONSTRUCTION DETAILS.

17. The structure shall be built as a monolith, that is, with no interruption in the work, proceeding, if necessary, night and day.

GENERAL REQUIREMENTS.

18. Imperfect work or materials, or work or materials which may become damaged from any cause before its acceptance, shall be properly replaced to the satisfaction of the Engineer.

Foremen employed by the contractor shall be skilled in concrete mixing, and they shall receive and obey orders from the Engineer.

No claims for extra work shall be allowed unless made in writing previous to its performance and signed by both parties or by their authorized representative.

SPECIFICATIONS FOR PURCHASE OF PORTLAND CEMENT.

PACKAGES.

1. Cement shall be placed in strong cloth or canvas sacks. Each package shall have printed upon it the brand and the name of the manufacturer. Packages received in broken or damaged condition may be rejected or accepted as fractional packages.

WEIGHT.

2. Four bags shall constitute a barrel, and the average net weight of the cement contained in



one bag shall not be less than 94 pounds or 376 pounds net per barrel. A cement bag may be assumed to weigh one pound. The weight of the separate packages shall be uniform.

REQUIREMENTS.

3. Cement failing to meet the seven-day requirements may be held awaiting the result of the twenty-eight day test before rejection.

TESTS.

4. All tests shall be made in accordance with the method proposed by the Committee on Uniform Tests of Cement of the American Society of Civil Engineers, presented to the Society January 21, 1903, and amended January 20, 1904, with all subsequent amendments thereto.

SAMPLING.

5. Samples shall be taken at random from sound packages, one from every ten barrels or 40 bags, and mixed. The total sample should weigh about ten pounds.

6. The acceptance or rejection shall be based on the following requirements;



DEFINITION OF PORTLAND CEMENT.

7. This term is applied to the pulverized product resulting from the calcination to incipient fusion of an intimate mixture of properly proportioned argillaceous and calcaraceous materials, and to which no addition greater than 3% has been made subsequent to calcination.

SPECIFIC GRAVITY.

8. The specific gravity of the cement, ignited at a low red heat, shall not be less than 3.10, and the cement shall not show a loss on ignition of more than 4%.

FINENESS.

9. It shall leave by weight a residue of not more than 8% on the No. 100, and not more than 25% on the No. 200 sieve.

TIME OF SETTING.

10. It shall not develop initial set in less than thirty minutes, and must develop hard set in not less than one hour nor more than ten hours.



TENSILE STRENGTH.

11. Briquettes one inch square in section shall attain at least the following tensile strengths and shall not show retrogression within the period specified:-

NEAT CEMENT.

AGE.	STRENGTH.
24 hours in moist air,-----	175 pounds
7 days (1 day in air, 6 days in water)	500 pounds
28 days(1 day in air,27 days in water)	600 pounds
7 days (1 day in moist air,6days in water)	150 pounds
28 days (1 day in moist air,27 days in water)	200 pounds.

SOUNDNESS OR CONSTANCY OF VOLUME.

Pots of neat cement, about three inches in diameter, one-half inch thick, at the center, and tapering to a thin edge, shall be kept in moist air for a period of twenty-four hours.

(a) A pot is then kept in air at normal temperature, and observed at intervals for at least 28 days.

(b) Another pot is kept in water maintained as near 70 Fahr. as practicable, and observed at intervals for at least 28 days.

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(c) A third pot is exposed in any convenient way in an atmosphere of steam, above boiling water, in a loosely closed vessel for five hours.

These pots to satisfactorily pass the requirements shall remain firm and hard and show no signs of distortion, checking, cracking or disintegration.

SULPHURIC ACID AND MAGNESIA.

13. The cement shall not contain more than 1.75% of anhydrous sulphuric acid (SO_3), nor more than 4% of Magnesia (MgO).

12th

TABLE OF APPROXIMATE COST OF SEWER PIPE.

Length in feet	Size in inches	Average Cut	Cost per foot	Total Cost
21190	8	8.4	\$.74	\$15680.60
16370	10	4.9	.63	10313.10
9490	12	4.9	.76	7212.40
1610	15	4.7	.89	1441.80
6280	18	5.4	1.20	7536.00
2520	20	4.4	1.33	3351.60
3550	22	4.7	1.56	5538.00
2560	24	4.3	1.73	4428.80
1900	30	5.7	2.70	5130.00
660	36	8.5	3.81	2514.00
1190	42	6.4	4.21	5009.90
2320	48	7.4	4.70	10904.00
375	60	11.6	5.75	<u>2156.25</u>
				81217.05
Manholes, 331 @ \$25.00 each				8275.00
Catch Basins, 277 @ \$27.00 each				7479.00
Interceptors, 3 @ \$200.00 each				600.00
Disposal Plant(Including land, steel, etc.)				<u>12000.00</u>
TOTAL COST OF SYSTEM				<u>\$109571.05</u>

ESTIMATE
OF
APPROXIMATE COST OF CONSTRUCTION
OF
SEPARATE SEWER SYSTEM AND
SEPTIC TANK
FOR
THE CITY OF ARLINGTON HEIGHT, ILL.

[illegible]

ARLINGTON HEIGHTS, ILL.

SEWERAGE SYSTEM

THESIS BY

JOHN JOHANNES

PAUL J. CHOR

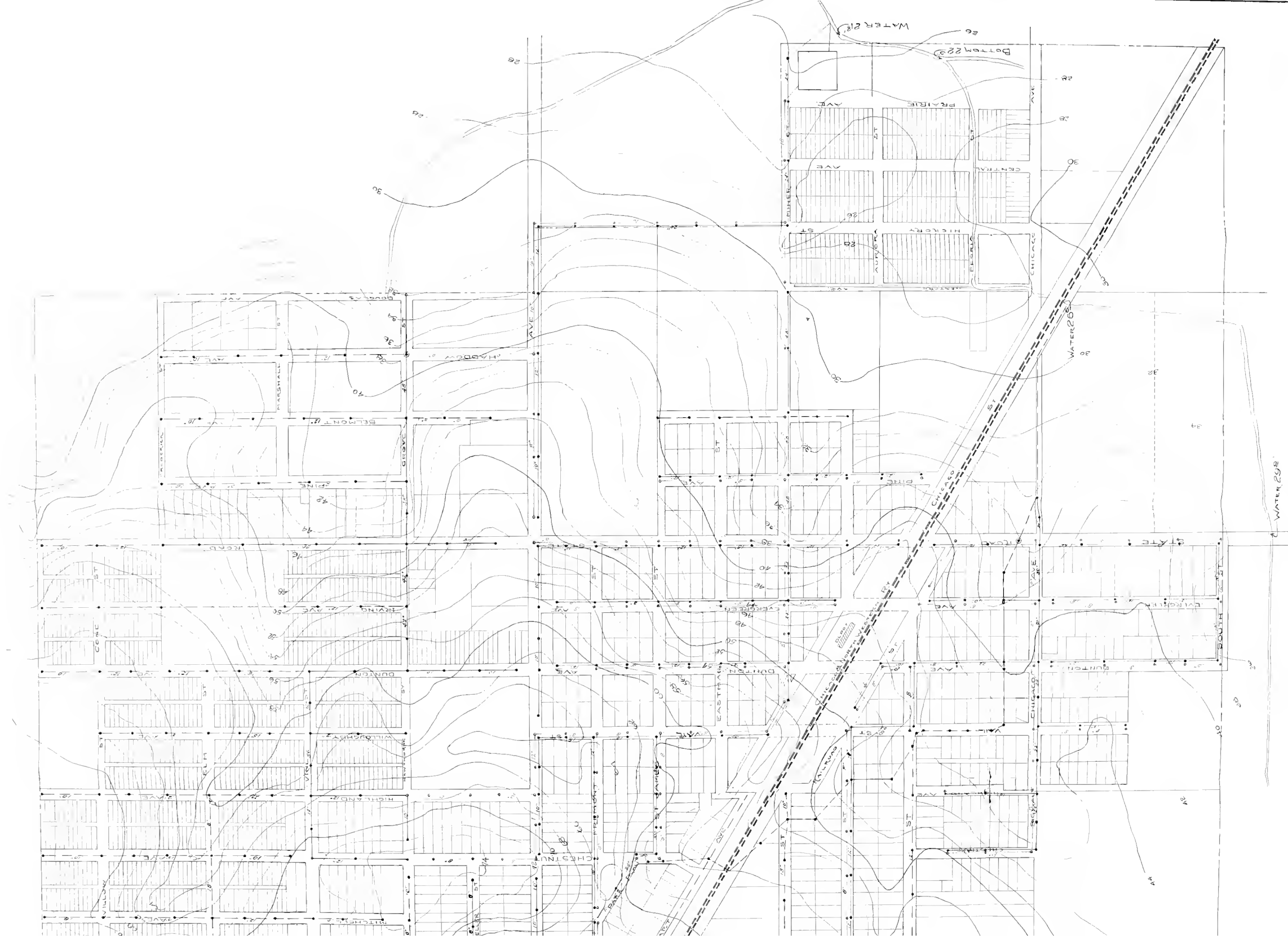
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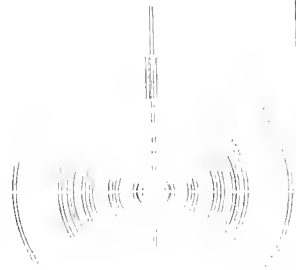
PLATE 2

Scale: 800 ft. = 1 in.
Old Sewerage: ———
New Sewerage: ———
Storm Sewers: ———
Sanitary Sewers: ———



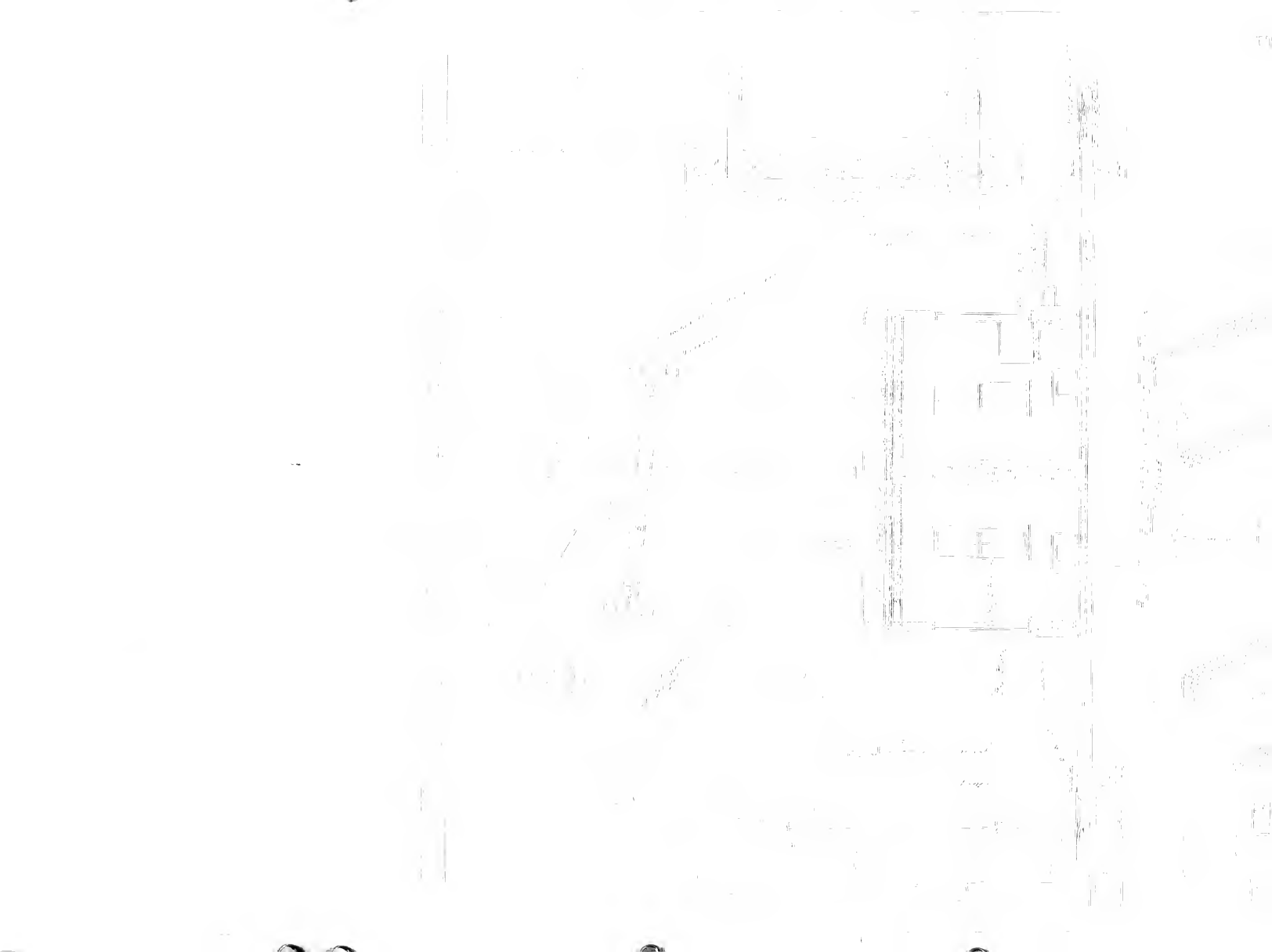


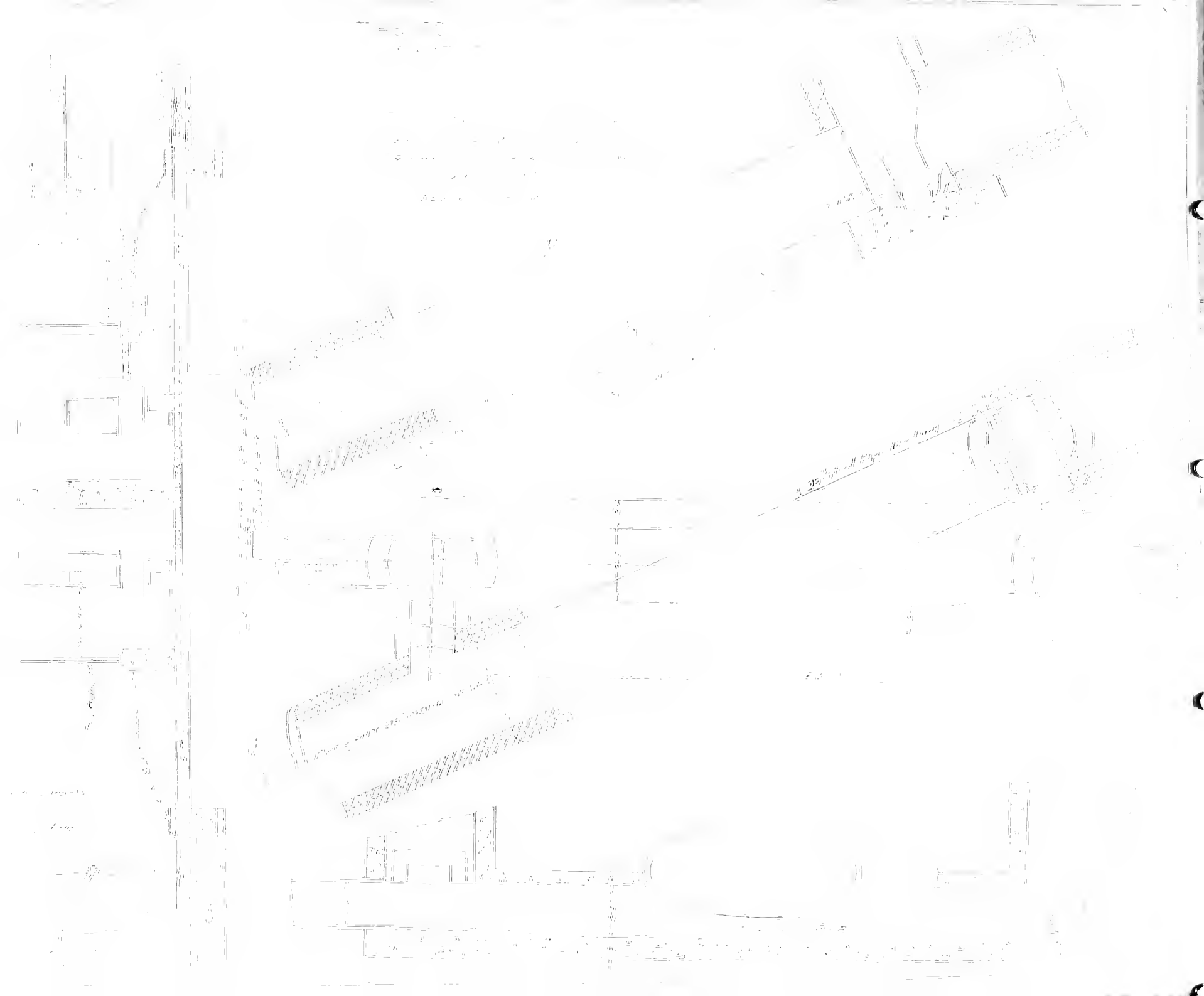




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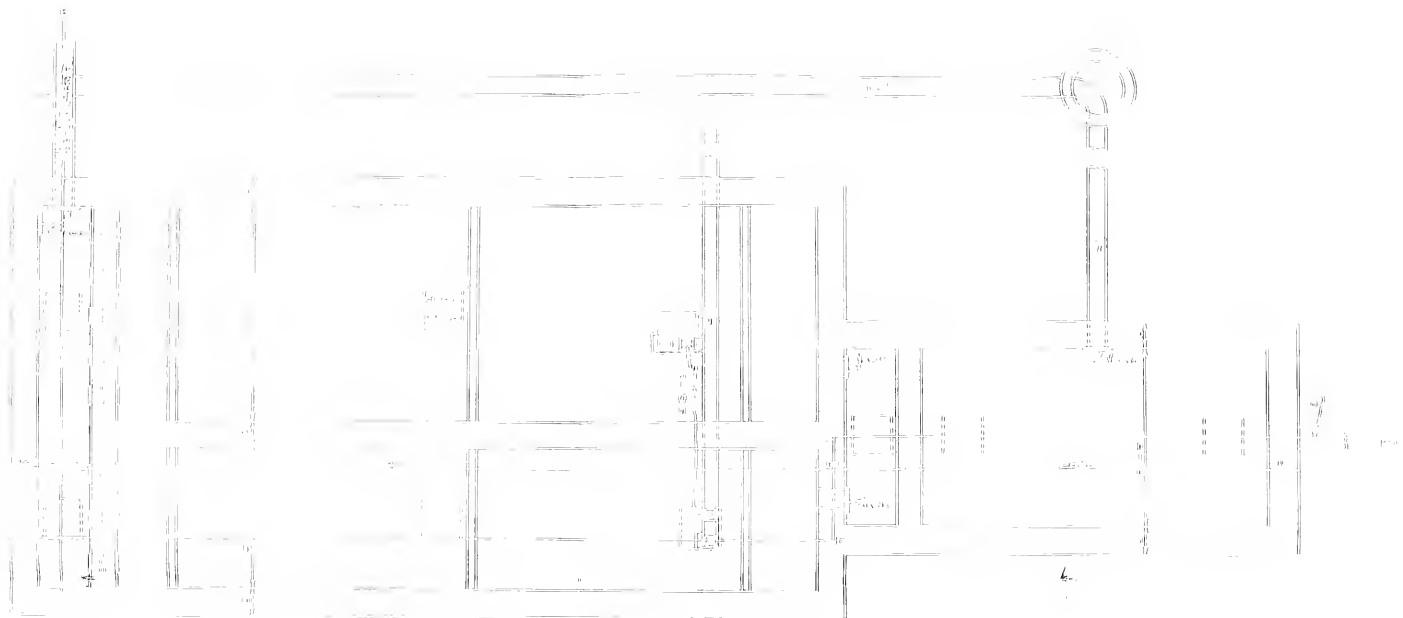


图 1 为 1954 年 10 月 1 日
 1954 年 10 月 1 日

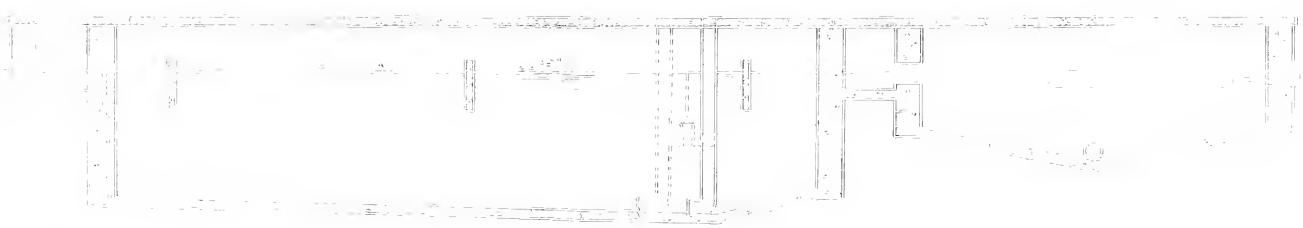


图 2 为 1954 年 10 月 1 日
 1954 年 10 月 1 日

MINER - STATE TO PRAIRIE

THE SIS

Chandler Clark-Newfeld

Sanitary Sewers
Storm Sewers
Combined Sewers
Manhole
Drop Manhole
Interceptor

• • •
• • •
• • •

Scale Horizontal 200' = 1"
Vertical 4" = 1"

MINER - WESTERN TO PRAIRIE

Datum 20'

Datum 20'

STA.	10	12	11	10	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
ELEV.	26	34	35	34	34	33	32	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13



SOUTH - DUNTON TO STATE

CAMPBELL - VAIL TO EVERGREEN

MINER - VAIL TO STATE

MUELLER - WALNUT TO CHESTNUT

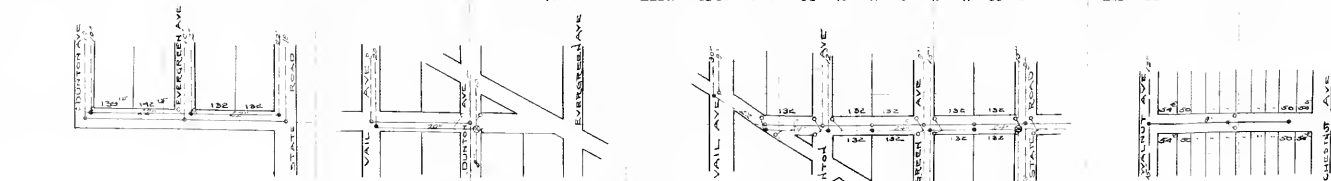
Datum 20'

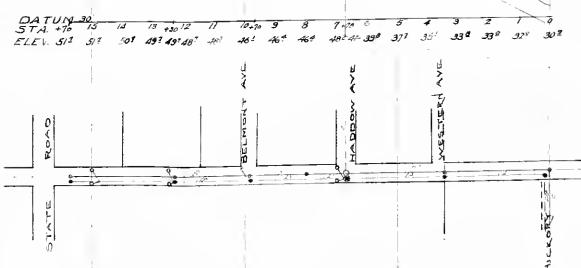
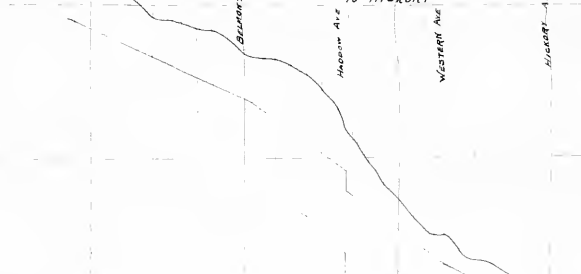
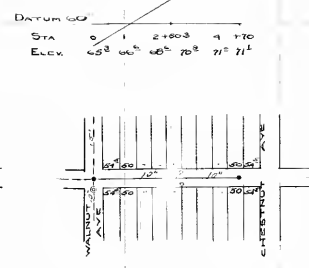
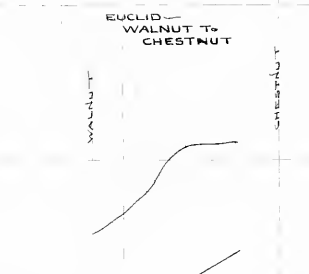
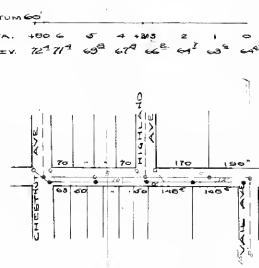
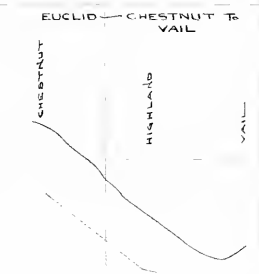
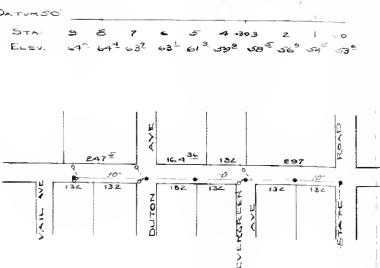
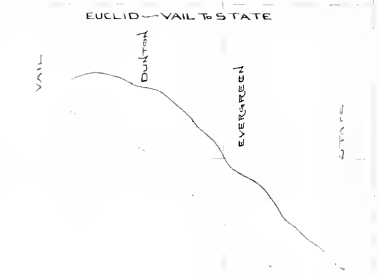
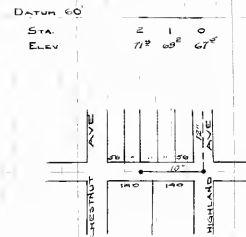
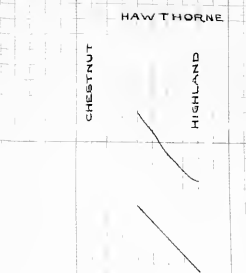
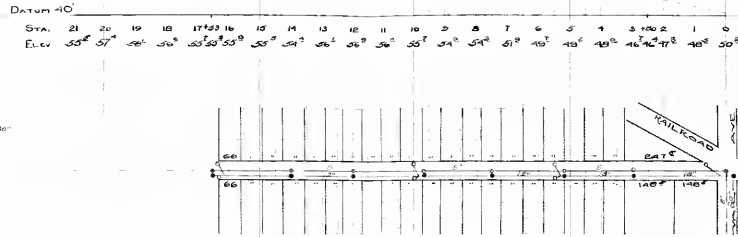
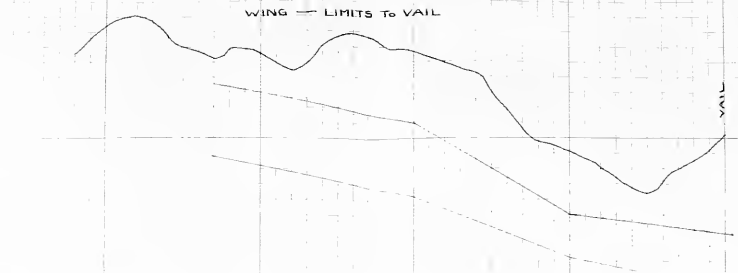
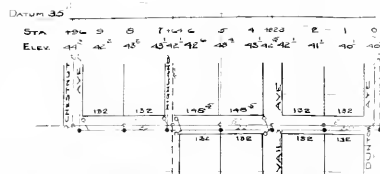
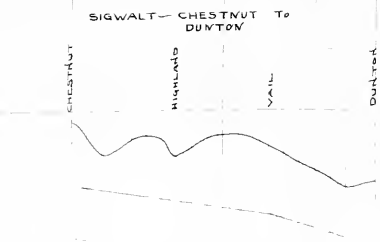
Datum 30'

Datum 30'

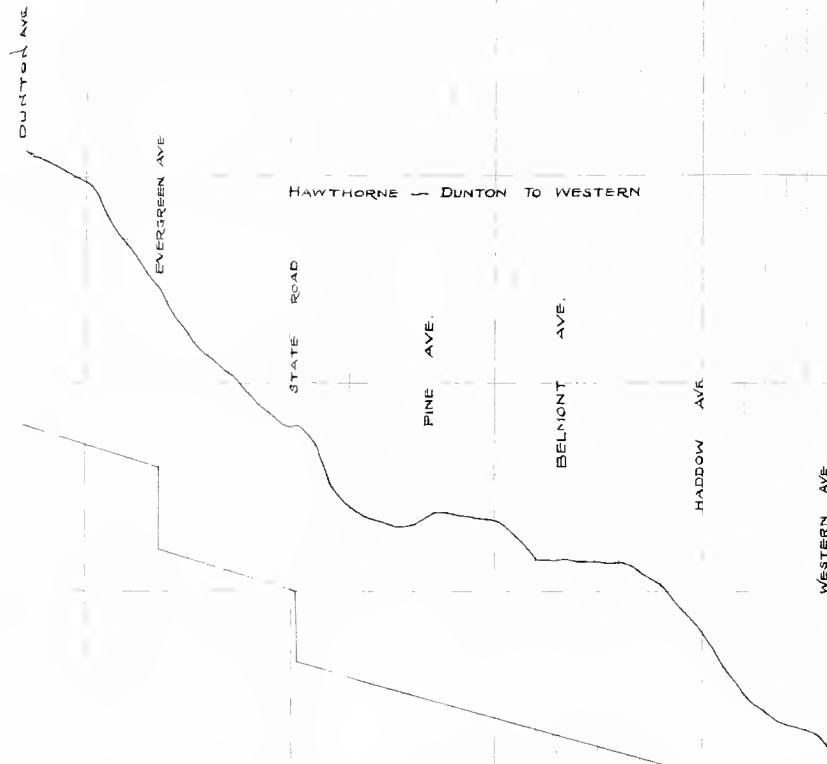
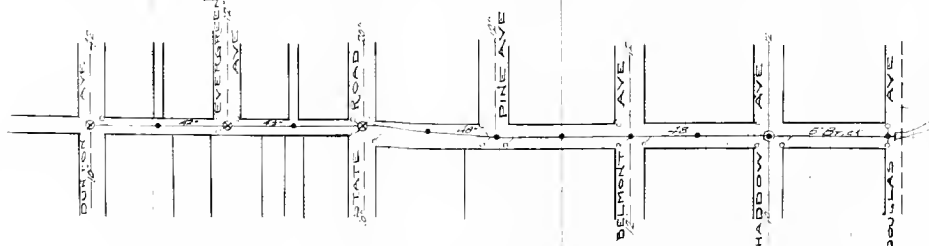
Datum 50'

STA.	106	105	104	103	102	101	100	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80
ELEV.	36	35	35	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12

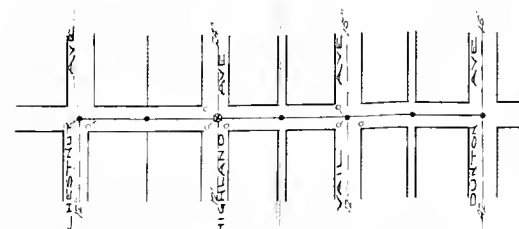




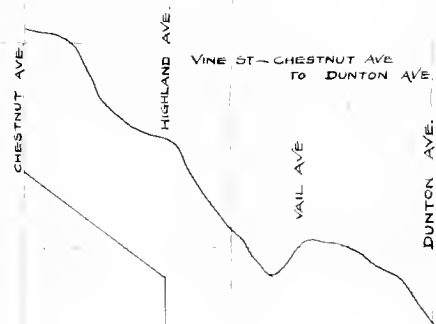
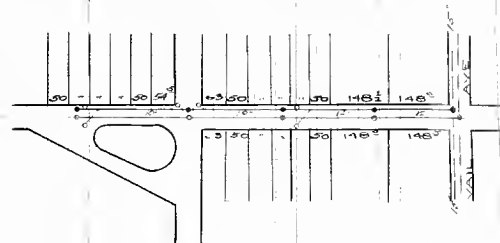
DATUM 20
STA 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 1 2 3 +10
ELEV 42.00 42.03 42.05 42.07 42.09 42.11 42.13 42.15 42.17 42.19 42.21 42.23 42.25 42.27 42.29 42.31 42.33 42.35 42.37 42.39



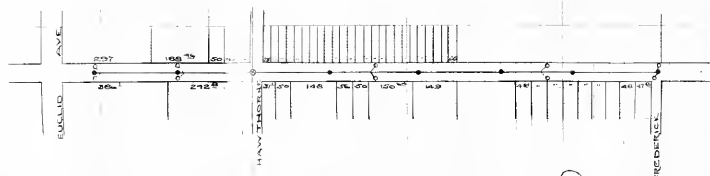
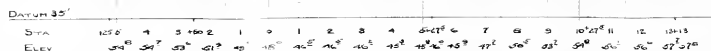
DATUM 50
STA 10 9 8 7 6 5 4 3 2 1 0
ELEV 70.0 70.0 70.0 70.0 70.0 70.0 70.0 70.0 70.0 70.0 70.0



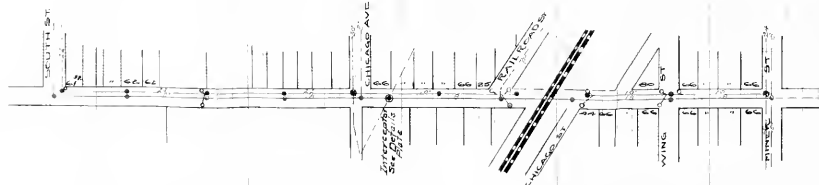
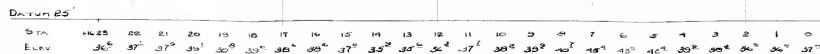
DATUM 50
STA 8 7 6 5 4 3 2 1 0
ELEV 66.5 66.1 65.7 65.3 64.9 64.5 64.1 63.7 63.3 62.9



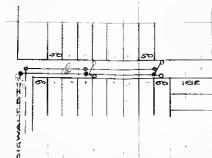
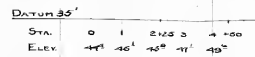
STATE ROAD — EUCLID TO FREDERICK



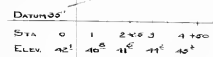
STATE ROAD — SOUTH TO MINER



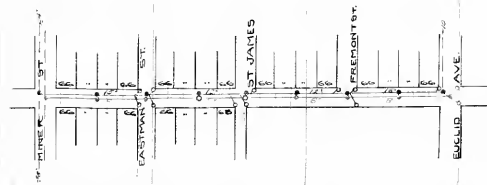
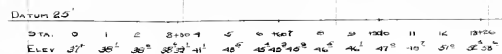
CHESTNUT — SIGWALT TO CAMPBELL

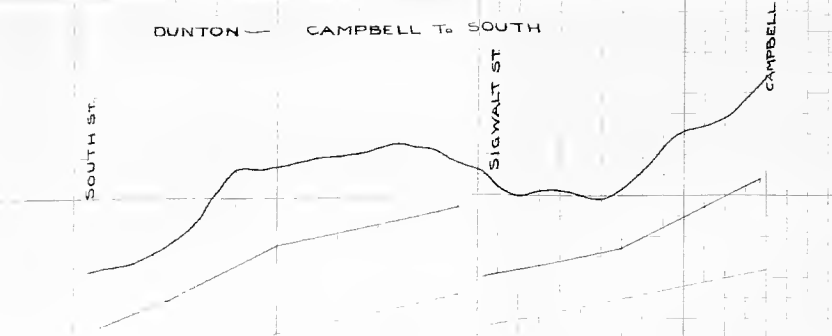


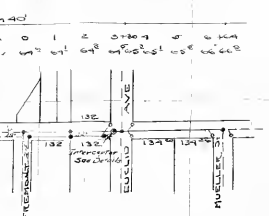
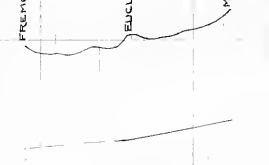
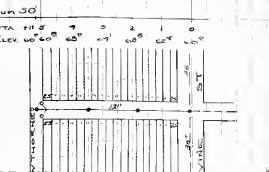
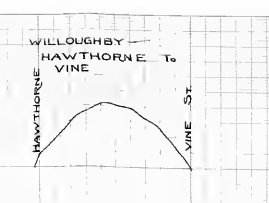
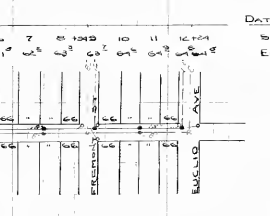
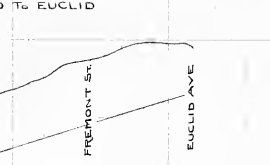
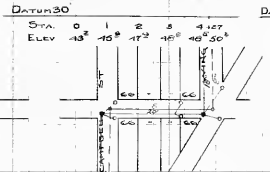
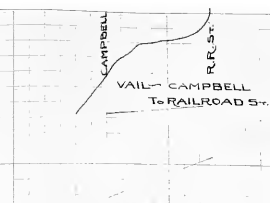
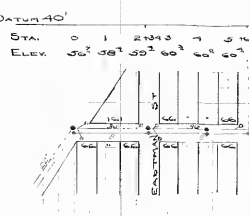
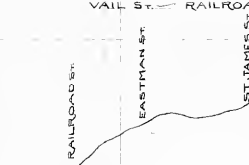
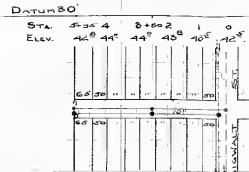
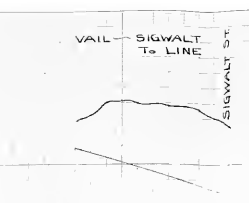
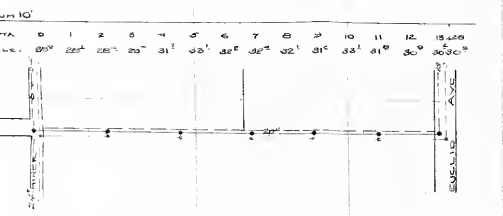
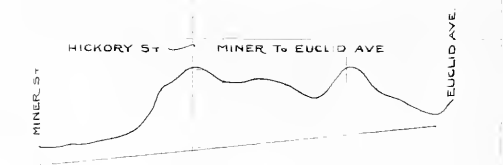
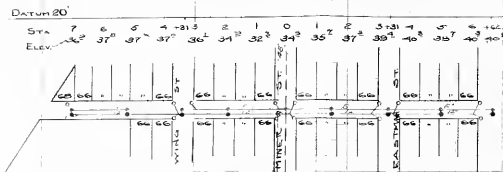
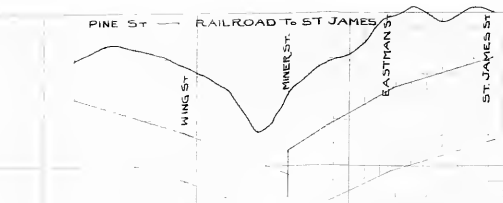
HIGHLAND — SIGWALT TO CAMPBELL



STATE ROAD — MINER TO EUCLID







CHESTNUT AVE EUCLID TO HAWTHORNE

EUCLID

MUELLER ST.

HAWTHORNE

CHESTNUT HAWTHORNE TO VINE

VINE

HAWTHORNE

HIGHLAND HAWTHORNE TO VINE

VINE

EUCLID

HIGHLAND EUCLID TO HAWTHORNE

RAILROAD EVERGREEN TO STATE ROAD

DATUM 60'

STA 0 1 2 3+35.4 4 5+90
Elev. 72.7 73.0 73.0 74.2 74.6 74.8

DATUM 60'

STA. 110 4 3 2 1 0
Elev. 75.7 74.5 74.5 73.5 72.5 70.2

DATUM 50'

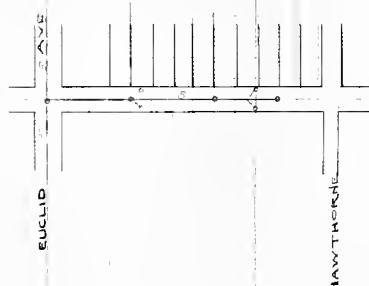
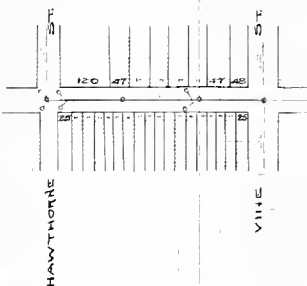
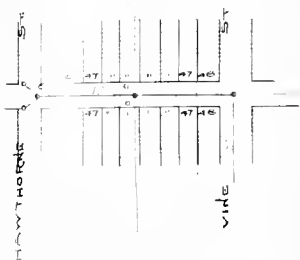
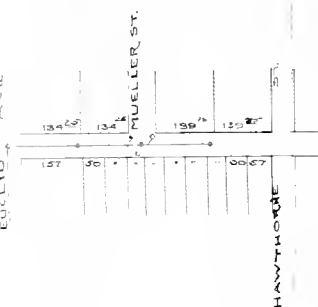
STA. 110 4 3 2 1 0
Elev. 67.6 67.2 67.2 66.2 66.2 66.2

DATUM 50'

STA. 0 1 2 3 4 5+50
Elev. 66.7 68.1 68.1 69.5 67.8 67.7

DATUM 20'

STA. 181 3 2 1 0
Elev. 74.2 43.3 42.3 41.2 39.2



WALNUT HOBART TO RIDGE

FREMONT PARK PLACE TO ST. JAMES ST.

DUNTON RAILROAD ST.

CHICAGO DUNTON TO STATE

DUNTON EVERGREEN STATE

DATUM 50'

STA. +60.8 7 6+63.6 4 3 1+22 1+75.0
Elev. 66.6 66.6 66.6 67.6 67.6 67.6 67.6 67.6 67.6

DATUM 50'

STA. +34.4 18 +27.1 11 10 9 8 7+73.6 5 4 +50.0 2 1 0
Elev. 67.6 66.6 67.6 67.6 66.6 66.6 66.6 66.6 66.6 66.6 66.6 66.6 66.6

DATUM 30'

STA. 0 1 +31.2 3 4 6+33
Elev. 45.2 46.4 41.4 41.2 48.5 49.5 49.5

DATUM 30'

STA. 0 1 2 3+83.4 5 6 +100
Elev. 10.0 10.0 10.0 10.0 10.0 10.0

